

PHYSICAL PROPERTIES OF ERUPTING SOLAR PROMINENCES

J. Lewis Fox and Roberto Casini

27 March 2013

Interim Report

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.



**AIR FORCE RESEARCH LABORATORY
Space Vehicles Directorate
3550 Aberdeen Ave SE
AIR FORCE MATERIEL COMMAND
KIRTLAND AIR FORCE BASE, NM 87117-5776**

DTIC COPY

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the 377ABW Public Affairs Office and is available to the general public, including foreign nationals. Copies may be obtained from the Defense Technical Information Center (DTIC) (<http://www.dtic.mil>).

AFRL-RV-PS-TR-2013-0097 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

//SIGNED//

Dr. Richard C. Altrock DR-IV
Principal Astrophysicist
Manager, Coronal Research Program/RVBXS

//SIGNED//

Edward J. Masterson, Colonel, USAF
Chief, Battlespace Environment Division

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YY) 27-03-2013		2. REPORT TYPE Interim Report		3. DATES COVERED (From - To) 21 Mar 2011 – 27 Mar 2013	
4. TITLE AND SUBTITLE Physical Properties of Erupting Solar Prominences				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 61102F	
6. AUTHOR(S) J. Lewis Fox and Roberto Casini				5d. PROJECT NUMBER 3001	
				5e. TASK NUMBER PPM00012251	
				5f. WORK UNIT NUMBER EF004374	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Research Laboratory Space Vehicles Directorate 3550 Aberdeen Avenue SE Kirtland AFB, NM 87117-5776				8. PERFORMING ORGANIZATION REPORT NUMBER AFRL-RV-PS-TR-2013-0097	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL/RVBXS	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. (377ABW-2013-0569 dtd 08 Jul 2013)					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT Our goal is to determine the spectro-polarimetric properties of solar prominences leading to their activation and/or eruption into the interplanetary medium as coronal mass ejections (CMEs). This is accomplished by measuring the velocity and three-dimensional magnetic field of prominences using a new instrument, the Prominence Magnetometer (ProMag). This unique database will be used to study the structure and evolution of prominences, including their intimate interaction with the magnetic fields responsible for their support in the solar corona, until such time as they may erupt. The anticipated future result is the ability to predict the eruption of individual prominences and the following CMEs from the observable characteristics of the prominences. The impact of CMEs on geospace often produces severe space weather effects on Air Force systems. We have accomplished the successful construction, installation at the proposed research site, verification of the design concept and initial observations.					
15. SUBJECT TERMS: solar prominences, solar prominence eruption, solar prominence magnetic field					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Unlimited	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON Dr. Richard C. Altrock
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code)

This page is intentionally left blank.

Physical Properties of Erupting Solar Prominences

AFOSR Lab Days, 27 Mar 2012

**J. Lewis Fox National Solar
Observatory AFOSR Associate
Post-
doctoral researcher**

**Roberto Casini
High Altitude Observatory**

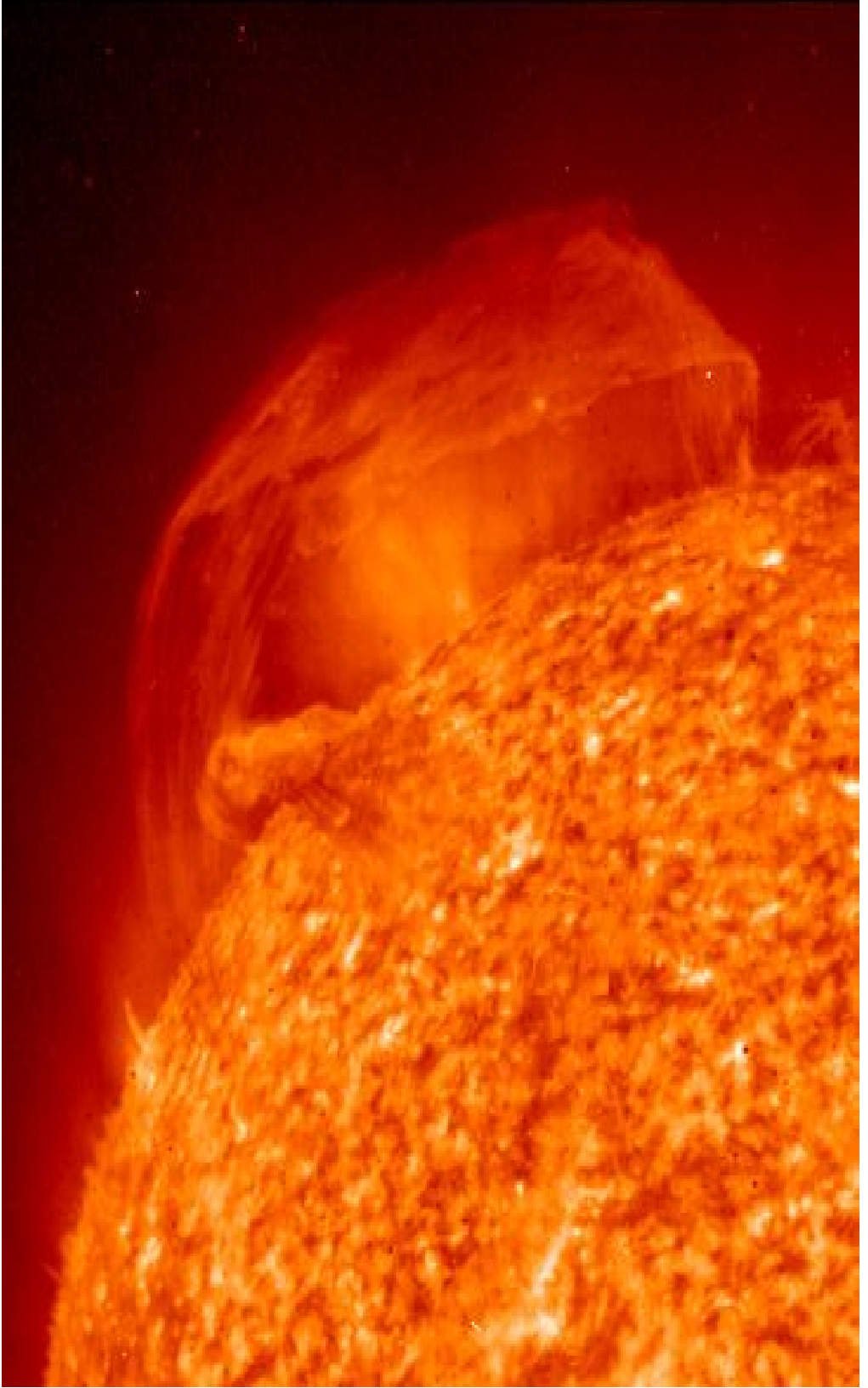
Abstract

Our goal is to determine the spectro-polarimetric properties of solar prominences leading to their activation and/or eruption into the interplanetary medium as coronal mass ejections (CMEs). This is accomplished by measuring the velocity and three-dimensional magnetic field of prominences using a new instrument, the Prominence Magnetometer (ProMag). This unique database will be used to study the structure and evolution of prominences, including their intimate interaction with the magnetic fields responsible for their support in the solar corona, until such time as they may erupt. The anticipated future result is the ability to predict the eruption of individual prominences and the following CMEs from the observable characteristics of the prominences. The impact of CMEs on geospace often produces severe space weather effects on Air Force systems. We have accomplished the successful construction, installation at the proposed research site, verification of the design concept and initial observations.

Introduction

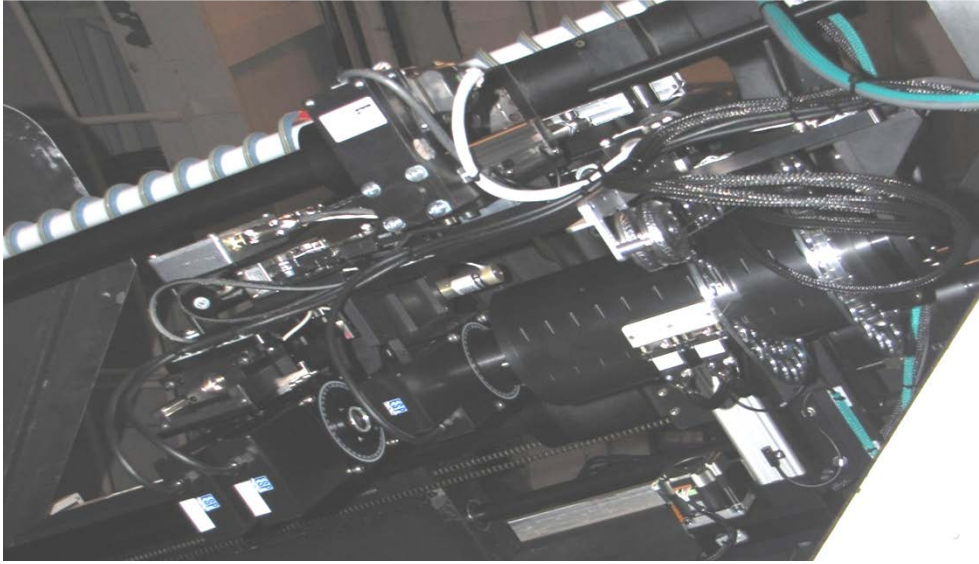
Solar prominences are aggregations of material in the solar corona of much higher density and much lower temperature than the corona. They are intimately connected with magnetic fields in the corona, which are rooted in the photosphere. At the current time, there is no agreement concerning their creation, how they are supported in the corona, magnetic fields, velocity fields, evolution and ultimate disappearance. We are attempting to provide answers to these questions through study of prominences using a new instrument, the Prominence Magnetometer (ProMag). This instrument was designed and constructed by the High Altitude Observatory (HAO) and installed in the John W. Evans Solar Facility (ESF).

A Prominence Observed by the SOHO Extreme Ultraviolet Imaging Telescope (EIT)



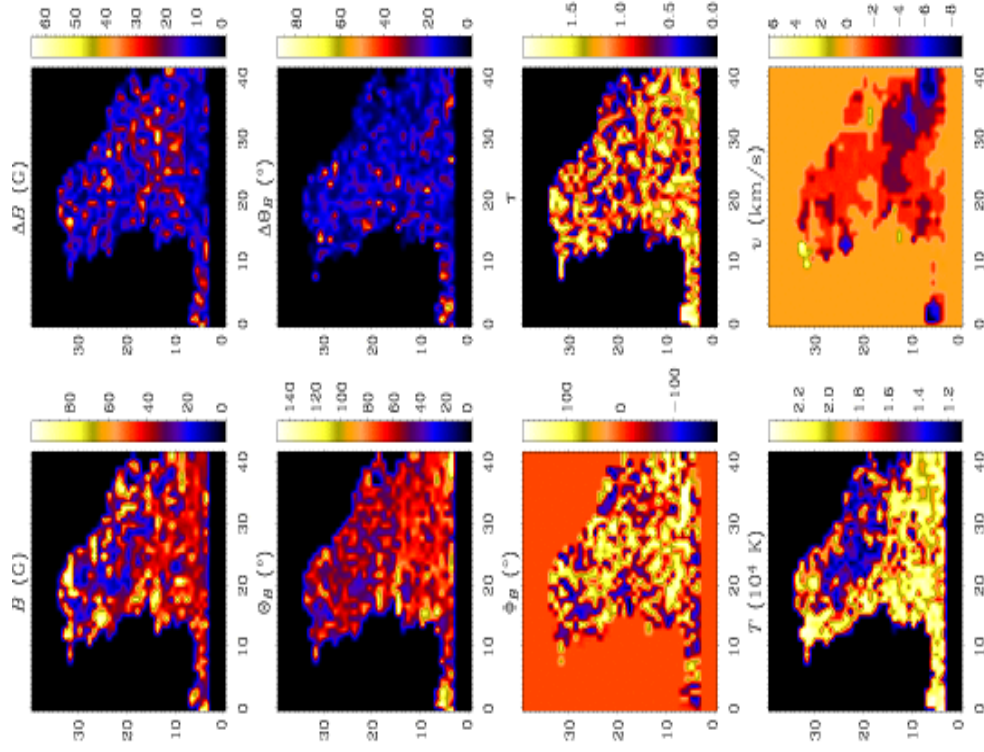
HAO Prominence Magnetometer (ProMag)

Polarization analyzer is an achromatic Ferroelectric Liquid Crystal modulator, previously situated inside the 40-cm coronagraph at NSO Sunspot. We are reconfiguring the instrument to perform analysis behind the entrance slit. This will improve polarimetric precision.

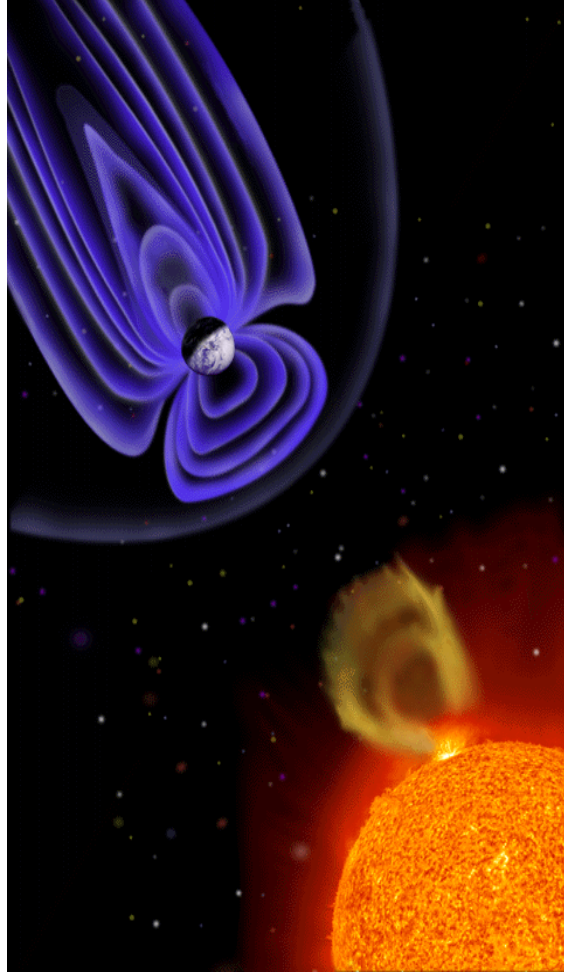


Prominence Magnetometer

Spectropolarimetry from **ProMag** will be used to derive the physical parameters of solar prominences in 3-D.



Expected outcome: Understanding of prominence eruptions that drive earthbound CMEs.



HAO Prominence Magnetometer

Spectropolarimetry from **ProMag** is used to derive physical parameters of solar prominences in 3-D.

Results: Progress made toward understanding of prominence eruptions that drive earthbound CMEs. Work continues with AFOSR Post-doctoral researcher Lewis Fox.

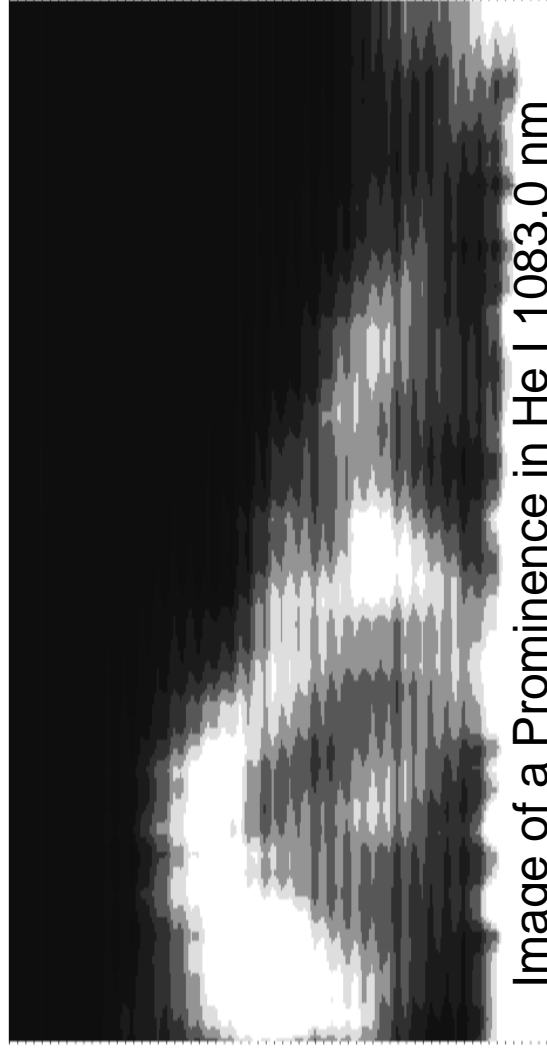
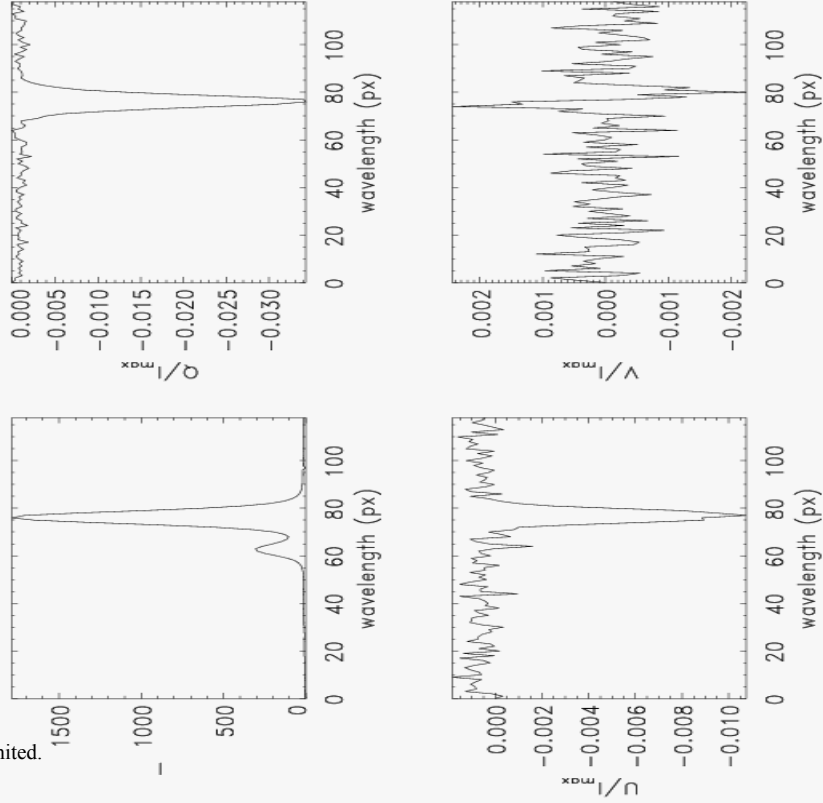


Image of a Prominence in He I 1083.0 nm
made with ProMag



He I 1083.0 nm Stokes Magnetic
Field Parameters I, Q, U and V
observed with ProMag

Moving Forward

We have made substantial progress towards the goal of observing prominences and analyzing their physical processes. Instrument reconfiguration should allow sufficient numbers to be observed with sufficient precision to understand the destabilizing forces that result in CMEs. Observations continue.

DISTRIBUTION LIST

DTIC/OCP 8725 John J. Kingman Rd, Suite 0944 Ft Belvoir, VA 22060-6218	1 cy
AFRL/RVIL Kirtland AFB, NM 87117-5776	2 cys
Official Record Copy AFRL/RVBXS/ Dr. Richard C. Altrock	1 cy

This page is intentionally left blank.